

# Underground Limestone Mining

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**The production of limestone aggregate from underground workings requires machinery to illuminate the rock face and to hoist miners into position to clean drill holes and load explosives for blasting the rock. River Products Company, Columbus Junction Mine.**

*Photo by Bob McKay and Mike Bounk.*

Each year aggregate companies in Iowa produce about 35 million tons of raw material from over 500 locations to supply a myriad of construction projects across the state. The bulk of this supply is extracted from the familiar pits and quarries where gravel deposits and limestone bedrock are close to the land surface. But at eight locations across the state (Jasper, Louisa, Marion, Poweshiek, Scott, Story, Van Buren, and Webster counties), where geologic and market conditions permit, limestone for aggregate is extracted from underground mines.

Though more costly than quarrying, the underground mining of limestone can be both economical and necessary in some areas of the state. Shallow rock units, which were once acceptable, may no longer meet newer engineering standards for construction aggregate. In other instances, it is not economical to strip both the overlying glacial deposits and the poorer quality, shallow bedrock in order to quarry. An operator must decide whether to cease production and move to an alternate location, if one exists, or to shift operations underground. Numerous factors are weighed to determine the feasibility of such a production change. Is the needed quality rock present in sufficient thickness and at suitable depth? Are the market conditions satisfactory to warrant the added expense of underground start-up and production? In the last decade several Iowa stone producers have opted to shift production underground.

Most underground mines in Iowa are opened from the floors of existing quarries. An entrance road or haulway is driven into the quarry wall or floor depending on whether the layers to be mined are at the same level as the floor or deeper. The depth of the mining level below the land surface may vary from 75 to 400 feet. Once the entrance road or ramp has reached the proper level, the mine is ready to go into production.

A major element of the mining process is breaking up the rock. This fragmentation is accomplished by detonating explosives set in blastholes. The heading, or rock face to be blasted, is typically 40-feet wide by 20- to 25-feet high. A designed pattern of 40 to 50 horizontal drill holes two inches wide by 12- to 14-feet deep, are bored into the rock face by large portable drills. This configuration of holes is called a "round." In a typical round, the holes are drilled at an angle with the free face. Five hundred or more pounds of explosives may be loaded in one round depending on the size of the face. The detonation devices, or blasting caps, have set delay times so that charges in the center of the face detonate first and the surrounding charges detonate two to several milliseconds later. Using this method, the explosives in the central angle-cut holes blast the rock into the open area in front of the face, allowing the delayed charges to thrust material into and past the initial blast opening. A typical operation can drill and blast up to five rounds per day, loosening tons of rock in several different headings. The time-delayed explosions not only increase blast efficiency, but greatly reduce ground vibration.

Front end loaders then lift the rock into haul trucks which transport it to a rock crusher sometimes outside the mine. In deep mines, such as the Kaser Corporation's Durham Mine in Marion County, the primary crusher is inside the mine, and crushed rock is moved via conveyor belt through an inclined tunnel to the surface where it is processed further.

As the mine become larger, the primary means of ceiling support are the pillars of rock left in place between the rooms of mined out rock. This "room and pillar" mining plan is often mapped out in advance with the help of engineering firms specializing in underground developments. Secondary roof stabilization, if necessary, usually involves mechanical scaling of loose slabs of rock from the ceiling, and less frequently, mechanical bolting of potentially loose ceiling rock to more sound rock above.

An occasional problem related to local geologic conditions occurs when a room intersects a shale or sediment-filled cavity in the limestone. The material in these paleo-karst features usually extends above the ceiling, has little supporting strength, and can collapse into the mine. A combination of roof bolts and supporting wire mesh is sometimes used to stabilize this condition. At worst, that portion of the mine may have to be closed off from further activity. Safety decisions are usually determined by federal inspectors from the Mine Safety and Health Administration, in consultation with the operator.

Controlling groundwater is another important aspect of mining operations. Water is usually present at some depth below the surface; and once encountered by mining, open crevices, fractures, and solutional voids in the limestone may produce variable flows of groundwater. This inflow must be routed along drainage slopes and ditches to collection

places where it can be discharged from the mine. Most operators eventually need to collect water in a sump, or low spot, within the mine and pump it out from that point. On rare occasions, a heading may intersect a fracture or void which releases hundreds of gallons of water per minute. If the problem cannot be remedied, a portion or all of the mine may be closed.

Proper ventilation also must be maintained in any underground mine. Exhaust fumes from machinery must be vented and fresh air introduced. Natural ventilation of level headings is adequate when mine workings are not extensive. Warm air, either from outside or within the mine, will flow along the ceiling while cool air will move along the floor. As the workings are extended, however, forced ventilation becomes necessary. Fans move air from one or more exterior openings to the active part of the mine. As workings progress or become deeper, the producer may have to drill large-diameter vertical ventilation shafts from the surface to the mine level. Large volume ventilation fans are installed which move air down, usually in colder weather, and can be reversed to move air up during warmer humid weather.

Although operations of an underground limestone mine are more expensive and require some specialized techniques to overcome inherent difficulties, there are also significant advantages to underground stone extraction. Stripping unneeded overburden, a costly inconvenience in surface operations, is eliminated. The land above the mine can be utilized for other purposes simultaneously with stone removal. Reclamation of disturbed land and its associated costs are reduced. Noise and dust pollution are generally contained within the mine. Working conditions, while dark, are arguably more comfortable because mine air temperature hovers around 50 degrees F throughout the hot summers and cold winters.

If geologic conditions are suitable and proper planning has been done, large portions of the mine workings may eventually be converted to usable underground space. This space can be utilized for warehouses, offices, industrial production, agricultural product storage, and even recreational facilities, such as tennis courts. In Scott Co., Iowa, small portions of the Linwood mine are being converted into mine managers' office areas, and in Clayton County, an abandoned underground sandstone mine is used as a storage facility. Underground mining in urban areas can be an attractive future alternative when the stone producer must compete with other land uses and increasing land acquisition costs.

Throughout most of Iowa, production of limestone aggregate from surface quarries will undoubtedly remain the principal method of mining. Underground mining, however, is an important and an increasingly common method of limestone production in the state.

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